

# Diabetic Patients with Myocardial Infarction

## The Diagnostic Accuracy of the Electrocardiogram

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THE ACCURACY of the electrocardiogram has been well established in the diagnosis of myocardial infarction in nondiabetic persons.<sup>3</sup> The assumption has been that the electrocardiogram should be just as able to corroborate the diagnosis of myocardial infarction in diabetic patients. Joslin<sup>1</sup> stated, "In diabetic patients the common electrocardiographic evidences of coronary occlusion are occasionally not obtained or [are] obscured for various reasons." In a survey of the American literature no studies substantiating this impression were found.

It has been often noted at the electrocardiographic clinicopathological conferences conducted at the Los Angeles County General Hospital that when the electrocardiogram failed to reveal the presence of a proved myocardial infarction, the patient usually had diabetes mellitus. The present study was undertaken to determine if any disparity exists in the accuracy of electrocardiographic diagnosis of myocardial infarction between diabetic and nondiabetic persons.

### METHODS

The cases for study were obtained from the autopsy files of the Los Angeles County General Hospital for the years 1948 to 1952 inclusive. In the first two years of the study, electrocardiograms consisted of the six chest leads (CF) in addition to the limb leads. In the second two years the augmented unipolar and V leads supplanted the CF leads.

Data on two groups of patients with "autopsy proved" myocardial infarctions were compared. The first group consisted of diabetic patients who had myocardial infarction, observed at autopsy, and whose records included electrocardiograms with precordial leads. The second series included 52 consecutive nondiabetic persons who had electrocardiograms and in whom myocardial infarction was observed at autopsy. Each series consisted only of cases in which it could be definitely determined that the infarction had occurred prior to the taking of the electrocardiograms. In two sets of readings for the diabetic group 53 and 56 cases met this criterion. The usual accepted electrocardiographic cri-

• In a study involving interpretation of electrocardiograms of two groups of patients who had myocardial infarction—one a group of diabetic patients and the other group made up of nondiabetic—the electrocardiogram was found to be considerably less accurate in the diagnosis of myocardial infarction in the diabetic patient than in the nondiabetic subject. This is due to the fact that the patterns which mask the diagnosis of myocardial infarction in nondiabetic patients occur more frequently in diabetic individuals. It is important to note that in no instance were the electrocardiograms interpreted as normal in the diabetic group.

teria were used in diagnosing the presence of a myocardial infarction. In addition if the electrocardiograms were interpreted as showing acute anoxia, injury or ischemia patterns, these were also counted as diagnostic of infarction. In these cases the assumption was that the actual muscle death had occurred shortly after the electrocardiogram was taken. In all cases the infarcts were transmural.

Two sets of interpretations of all the electrocardiograms were used. The first consisted of the interpretation by members of the electrocardiographic department, which is composed of junior and senior attending physicians of the medical staff of the Los Angeles County General Hospital, as well as a few third year medical residents. The second set was read by a consulting cardiologist of the senior attending staff of the Los Angeles County General Hospital.\* The following information was available to all the readers: Age, sex, blood pressure, and whether or not quinidine or digitalis was being administered. Only the first set of readers was aware of the clinical impression. The age of the infarct was determined from the information available in the autopsy protocols on the basis of the gross and microscopic descriptions of the pathologic material according to the criteria set forth by Mallory and co-workers.<sup>2</sup> As the age of the infarct in the first three weeks after it occurs can be judged fairly accurately from the histologic features, the material for this study was divided into two groups. The infarcts in which the pathological changes were such that they could be classified as occurring within

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TABLE 1.—Accuracy of Diagnosis of Infarction on Basis of Electrocardiograms in Diabetic and Nondiabetic Patients

Reader	Diabetic			Nondiabetic		
	Number Correct	Number Incorrect	Total	Number Correct	Number Incorrect	Total
Cardiologist.....	37 (66%)	19 (34%)	56	46 (88%)	6 (12%)	52
Staff.....	27 (51%)	26 (49%)	53	42 (81%)	10 (19%)	52

TABLE 2.—Accuracy of Diagnosis of Acute Infarction on Basis of Electrocardiograms in Diabetic and Nondiabetic Patients

Reader	Diabetic			Nondiabetic		
	Number Correct	Number Incorrect	Total	Number Correct	Number Incorrect	Total
Cardiologist.....	31 (72%)	12 (28%)	43	39 (93%)	3 (7%)	42
Staff.....	21 (50%)	21 (50%)	42	35 (83%)	7 (17%)	42

three weeks of the time that the electrocardiograms were recorded were designated as recent infarcts. The remaining ones were classified as old infarcts. In all instances the area of infarction or scar tissue measured two centimeters or more in diameter.

### RESULTS

The correctness of the electrocardiographic diagnosis of myocardial infarction as proved at autopsy in the diabetic and the nondiabetic groups is shown in Table 1. Both groups included all infarcts regardless of age. When results in the nondiabetic group were compared with those in the diabetic group, the inaccuracy of the electrocardiogram became apparent. In 52 nondiabetic patients myocardial infarction was correctly diagnosed by the staff in 42 or 81 per cent of the cases and by the consulting cardiologist in 46 or 88 per cent of the cases. These results compare favorably with those of Zinn and Cosby<sup>3</sup> who reported 80 per cent accuracy in a similar series of nondiabetic patients. In diabetic patients myocardial infarction was correctly diagnosed by the staff in only 27 of 53 cases, or 51 per cent, and by the consulting cardiologist in 37 of 56 cases or 66 per cent. These results were analyzed statistically and proved to be at a significant probability level.<sup>†</sup> The slight difference in accuracy between the two sets of readers did not prove to be significant.

It was thought that the inclusion of both recent and old infarcts in the same group was affecting the conclusions. Therefore the data were recalculated including only infarcts of three weeks or less in duration (Table 2).

The accuracy of the staff was 21 out of 42 cases or 50 per cent in the diabetic patients and 35 out of 42 or 83 per cent in the nondiabetic patients. The accuracy of the consulting cardiologist was 31 out of 43 or 72 per cent in the diabetic group and 39 out of 42 or 93 per cent in the nondiabetic group.

<sup>†</sup>All statistical analyses were determined by either the method of chi squared ( $\chi^2$ ) or the Fisher exact method for fourfold tables. The probability that these results could have occurred by chance was one in one thousand times.

TABLE 3.—Effect of Location of Infarction on Accuracy of Diagnosis by Electrocardiogram

Location of Infarct	Number Correct	Number Incorrect	Total
Involving septum .....	26	11	37
Anterior septal .....	16	6	
Posterior septal .....	9	3	
Anterior posterior septal....	0	2	
Pure septal .....	1	0	
Not involving septum .....	10	7	17
Anterior .....	4	1	
Posterior .....	6	6	

TABLE 4.—Electrocardiogram Patterns Obscuring Diagnosis (Readings by Consulting Cardiologist)

	Number of Cases
Left ventricular hypertrophy.....	6
Left bundle branch block.....	2
Right ventricular hypertrophy.....	1
Right bundle branch block.....	2
Supraventricular tachycardia .....	1
Auricular fibrillation .....	1
Digitalis effect .....	3
Hypopotassemia* .....	2
Abnormal electrocardiogram .....	1

\*Actually potassium levels were not abnormal.

The difference in accuracy as between the two groups was still significant.

An attempt was made to analyze the factors in the diabetic patients that may have accounted for these differences. When the groups were subdivided for this purpose, they became rather small and definite conclusions were not warranted. The diagnosis of infarction was made with equal facility whether the area of infarction involved the anterior, posterior or septal walls (Table 3).

The effects of electrolyte imbalance on electrocardiograms are well known. In this series most of the patients had a normal carbon dioxide combining power and nonprotein nitrogen blood levels at the time the electrocardiogram was recorded. In the few instances in which serum potassium levels were de-

terminated, they were normal. Acidosis was present in a total of ten cases. In eight of these ten cases the presence of an infarct was indicated by the electrocardiogram.

Neither the age nor sex of the patient, nor the duration and severity of diabetes had any bearing on the electrocardiographic accuracy.

Left ventricular hypertrophy, digitalis effect and bundle branch block accounted for the majority of interfering patterns (Table 4).

These patterns were similar to those listed by Zinn and Cosby<sup>3</sup> as interfering with the diagnosis of myocardial infarction in nondiabetic patients. It should be noted that in the presence of a known myocardial infarction, none of the electrocardiograms of the diabetic individuals was read as normal.

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